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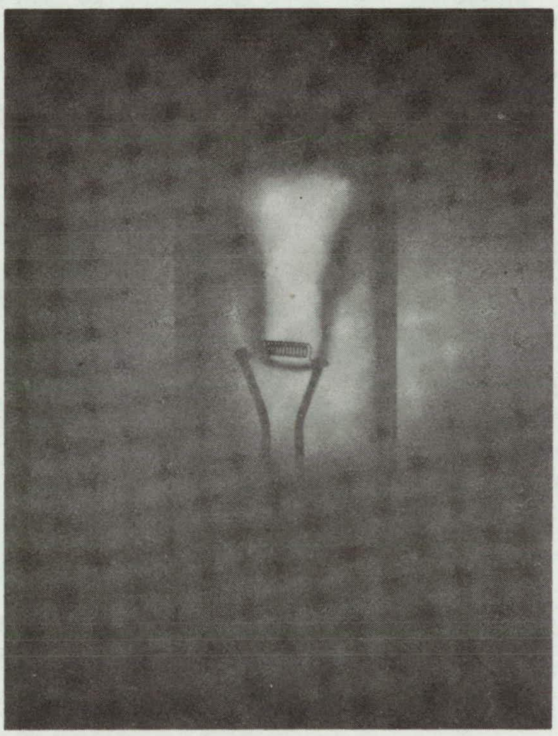
NASA TECH BRIEF

Two-Color Holography



Photographs of the two reconstructions from a single holographic interferogram of a projection lamp. The hologram was exposed simultaneously by the doubled and primary radiation from a Q-switched ruby laser. The filament of the lamp was heated between the two exposures, producing optical path length changes in the filling gas. Both images were reconstructed with a helium neon laser. The 0.6943 micron image is on the left. The other is the 0.347 micron or "doubled" image.

An important reason for the interest in holograms made with ultraviolet light is that smaller changes are visible because the shorter wavelength doubles the number of fringes in the holographic interferograms. Holograms have been made with uv radiation obtained by second harmonic generation in a KDP crystal fed with red light from a Q-switched ruby laser. The figure shows an example of a double-exposed holographic interferogram. This holographic interferogram was made by first exposing the plate with the lamp filament heated to a dull glow, causing density changes in the heated filling gas. The new

(continued overleaf)

aspect of this hologram is that two holograms are made simultaneously, one with the red light component (6943 Å) and one with the harmonic uv component (3471 Å). Two fringes are seen in the uv construction due to the shortened wavelength. Since both reconstructions were obtained with the 6328 Å beam from a He-Ne laser, the angle at which the uv construction occurs is approximately double that of the red construction. As a result, the two could be photographed separately.

The holographic arrangement consisted of a laser illuminator which included a 0.50-inch diameter x 3.75-inch long 60° ruby rod of high homogeneity, a nitrobenzene Kerr-cell Q-switch, an air-spaced Glan polarizer, and a one-centimeter diameter intercavity aperture. The optical resonator consisted of a 99% reflectivity, dielectric-coated optical flat and an output sapphire resonant-reflector. The laser emitted a 0.75 J pulse of red radiation of 50 nsec duration; this was sufficient energy to record a hologram on a full 4 x 5-inch plate. The output of the laser was passed through a KDP doubler, oriented to maximize the generation of uv radiation. Tests showed that the 5% conversion efficiency of the uv radiation was sufficient to expose the full plate area.

The combined beam from the laser was expanded by a simple lens and then divided into "scene" and "reference" beams by an elementary holocamera consisting of a glass beam splitter and three front-surface mirrors. A ground glass was placed 13.5 cm from the photographic plate in one beam; the light bulb scene was placed between the plate and the ground glass screen. Red holograms were made by placing, before the output of the doubler, a pair of filters which absorbed 99% of the uv energy; uv-only holograms were made by using a pair of red absorbing filters. For simultaneous red and uv holography, plates of partially absorbing uv glass were placed at the output of the doubler to balance the relative exposure.

An interesting observation made while viewing the hologram is that the angular orientation sensitivity of the plate is less for the uv (±23°), than it is for the red (±11°). This difference is apparently due to the absorption of the gelatin which rendered the effective thickness of the emulsion only 2.5 μ in contrast to the 11 micron thickness of emulsion utilized by the red.

The results demonstrate that doubling the ruby light is a practical method for gaining a factor of two in the sensitivity of holographic interferograms. By constructing a holocamera with uv grade optics, quality interferograms should be possible.

Note:

No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
Headquarters
National Aeronautics
and Space Administration
Washington, D.C. 20546
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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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